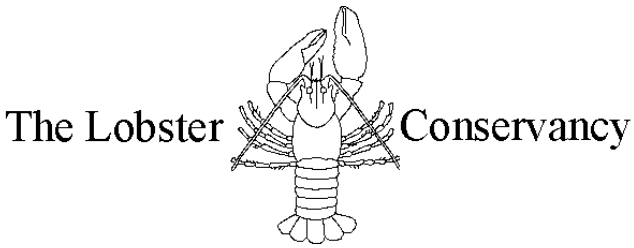


FINAL REPORT:

Intertidal Lobster Monitoring Program:

Penobscot Bay Lobster Collaborative, 1998 and 1999

Submitted to the Island Institute

by

Sara L. Ellis, Ph.D. and Diane F. Cowan, Ph.D.

October 1999

Introduction

The American lobster, *Homarus americanus*, is the single most important species to the fisheries of New England. For more than a century, efforts have been made to understand the factors that limit lobster abundance and thereby restrict recruitment to the fishery. In spite of the identification of postlarvae as the critical stage for lobster recruitment, measures of abundance (reported as mean number of individuals per meter squared) of the earliest juvenile stages (<10 mm CL) have appeared only over the past decade (Hudon 1987; Able et al. 1988; Heck et al. 1989; Wahle and Steneck 1991; Steneck and Wilson in prep.). Various methods have been used to quantify benthic abundance including visual surveys and airlift suction sampling (reviewed in Lawton and Lavalli 1995). The discovery of lobster nursery habitats in the lower intertidal zone has led to the design of a low-cost, long-term sampling program (Intertidal Lobster Monitoring Program) that may be used to study the settlement, abundance, and distribution of juvenile lobsters (Cowan 1999a, 1999b).

Penobscot Bay, Maine is one of the richest lobster grounds in the world. Factors controlling lobster recruitment and abundance are not fully understood, but it is believed that the high abundance in "Pen Bay" results from favorable environmental conditions for egg and larval survival and growth, which in turn lead to high settlement. There is growing consensus among scientists that initial recruitment in lobsters is closely related to abundance, delivery, and settlement of the last planktonic stage, called postlarvae. Annual delivery of postlarvae is likely affected by oceanographic currents (Incze et al. 1997).

Penobscot Bay provides an excellent laboratory for understanding how circulation, temperature patterns, wind forcing and geology regulate distribution and abundance of lobsters in coastal Maine waters. It is hypothesized that the Eastern Maine Coastal Current delivers postlarvae to Pen Bay by in late summer or early fall, when the current turns toward the mouth of the bay (Incze 1998).

The Penobscot Bay Lobster Collaborative is a multi-disciplinary, multi-agency research program being coordinated by the Island Institute as a component of the 5-year Penobscot Bay Project. The lobster collaborative brings together lobster biologists, oceanographers, and managers to study the principal factors and mechanisms underlying population fluctuations of lobsters.

In 1998, The Lobster Conservancy was invited to join the Penobscot Bay Lobster Collaborative, to establish its volunteer-based Intertidal Lobster Monitoring Program (ILMP) within Pen Bay. The Lobster Conservancy already had volunteers monitoring lobsters at Lowell's Cove, Maine, 8 other sites in Harpswell, ME and 1 site in New Hampshire (Cowan 1999a; Ellis and Cowan 1999a, 1999b). The main goal of the Pen Bay ILMP was to document patterns of abundance and distribution of juvenile lobsters around the bay, and to relate these patterns to oceanographic factors.

A secondary goal was to provide a strong educational outreach component to the lobster collaborative by involving volunteers from local communities. The ILMP uses standard, well-accepted ecological procedures to quantify general population dynamics of the American lobster. It also uses inexpensive, accessible, and readily available tools and techniques. Just about anyone with the time and inclination can participate in this program, thus it is perfectly suited for volunteers. Involving volunteers of different age groups and backgrounds aids in bringing communities together and provides public access to scientific research and knowledge.

Methods

Volunteers were recruited and trained through a series of presentations by TLC scientists Diane F. Cowan and Sara Ellis (Appendix). All volunteers were listed on TLC's special permit to handle sub-legally sized lobsters (Appendix) from the Maine Department of Marine Resources.

Volunteers for the Intertidal Lobster Monitoring Program monitor specific sites once per month during the spring low tides from May through October. In the case of the Pen Bay Lobster Collaborative, intertidal monitoring began at 5 sites in September/October 1998, then at an additional 13 sites in May/June 1999 (Table 1).

Choice of study sites was determined by two main factors: geographic location and habitat availability. Sites were spread around Penobscot Bay to cover a wide geographical range, to allow comparison of lobster abundance in outer regions versus inner regions of the bay, as well as eastern versus western regions (Figure 1). Selected sites had to have rocks that were large enough to provide shelter for lobsters, but small enough to be overturned by volunteers. One additional site without any rocks was surveyed in 1999, because volunteers on Vinalhaven found lobsters burrowing in eel grass beds.

Volunteers used a standard ecological method of data collection called quadrat sampling (Cowan 1999a; Cowan et al. 1999). This involved setting up a 20-meter long transect line along the water's edge, then sampling along the transect line in steps, one meter at a time. Each step was defined by placing a square-meter quadrat alongside the transect. Lobster monitors returned to the same transect line each month.

A qualitative description of each quadrat was made by estimating the substrate type and percentage rock cover, and recording the presence of marine organisms and macroalgae. Movable rocks in the quadrats were overturned one at a time, and organisms found beneath the rocks were recorded.

When juvenile lobsters were found, the following information was recorded: carapace length (from the rear of the eye socket to the posterior margin of the carapace), total length (from the tip of the rostrum to the tip of the telson), handedness (right or left crusher), sex (for lobsters measuring >15 mm carapace length), condition of appendages (i.e., missing, regenerating, damaged), shell condition (hard, brittle, or soft), rock dimensions (length by width by height), and depth of water under the rock. Carapace length was measured to the nearest 0.5 mm using calipers and total length using a ruler. Each lobster was returned to its shelter.

Data were entered into an Excel spreadsheet and analyzed using Excel and SPSS. Means are presented plus or minus 1 standard deviation. Lobsters with carapace lengths of less than 16 mm were defined as settlers, or young-of-the year lobsters (Cowan 1999a).

Table 1. The Lobster Conservancy's intertidal study sites, Penobscot Bay Lobster Collaborative, 1998 and 1999 (n = 18). An "X" indicates that lobster monitoring took place in a given month.

Site	Sept 98	Oct 98	May 99	June 99	July 99	Aug 99	Sept 99
Allen Island	-	X	X	X	X	X	X
Castine	-	-	X	X	X	-	-
Deer Isle	-	X	-	X	X	X	X
Isle au Haut	-	-	X	X	X	X	X
Islesboro: Grindle Pt.	-	-	X	X	X	X	X
Islesboro: Sprague Cove	-	-	X	X	X	X	X
Islesboro: Loranus Cove	-	-	X	X	X	-	-
Islesboro: Town Beach	-	-	X	-	X	-	-
Matinicus Island	-	-	-	X	X	X	-
Monhegan Island	-	-	-	X	X	X	-
Moose Point State Park	X	X	X	-	-	X	-
North Haven	-	-	X	X	X	X	X
Port Clyde	X	X	X	X	X	X	X
Rockport	-	-	-	X	X	X	-
South Thomaston	-	-	X	X	X	X	X
Stonington: Sand Beach	-	-	-	X	X	X	X
Vinalhaven: rocky	X	-	-	X	X	X	X
Vinalhaven: eel grass	-	-	-	X	X	X	X

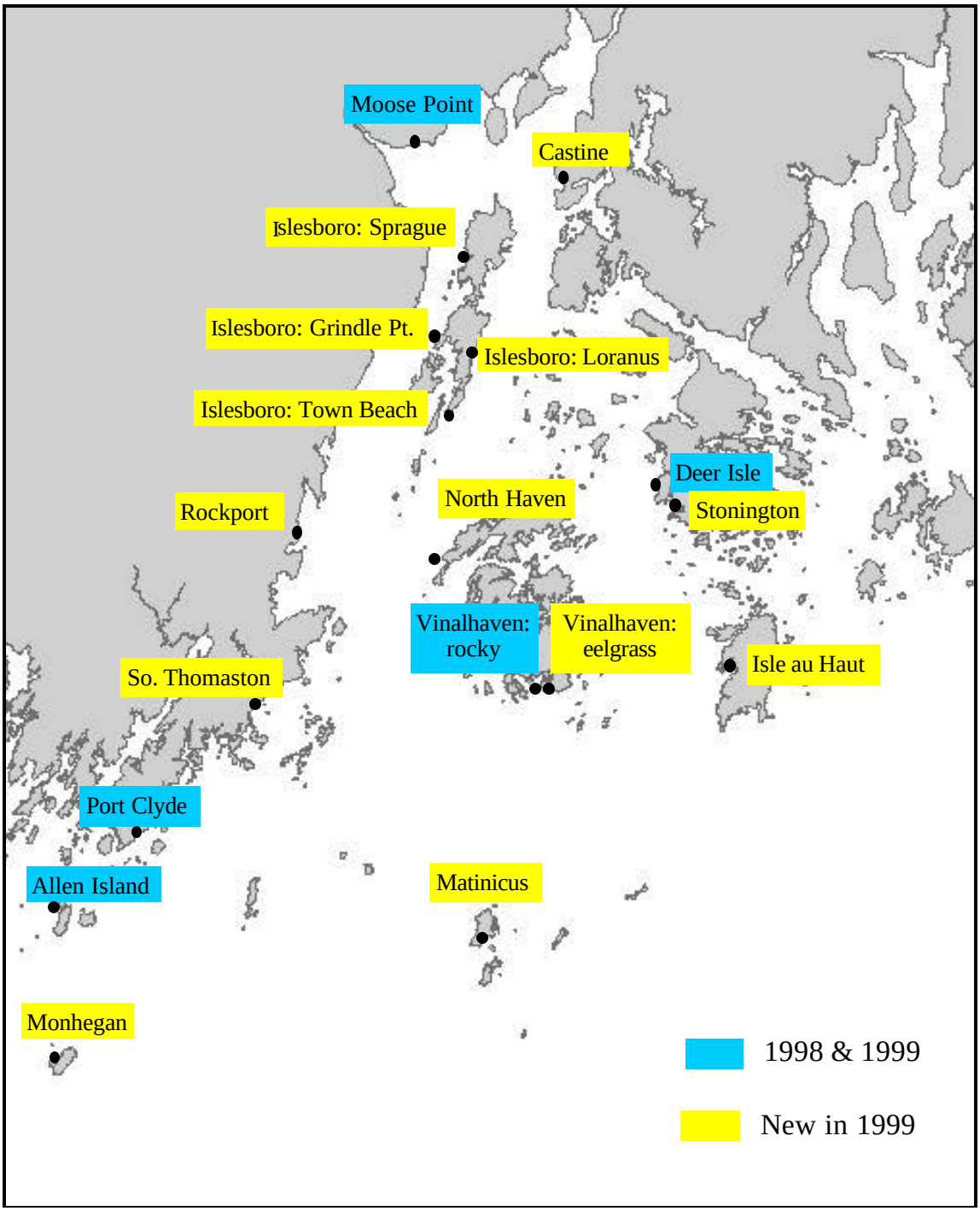


Figure 1. The Lobster Conservancy's intertidal study sites, Penobscot Bay Lobster Collaborative, 1998 and 1999 (n = 18). Five sites were studied in 1998 and an additional 13 sites were monitored in 1999.

Results

Overall

Lobsters were found at 8 of the 18 study sites (Figure 2). The size of rocks under which lobsters were found averaged 40 by 29 by 16 cm (Table 2), roughly 1.5 by 1.0 by 0.5 feet. The depth of standing water under these rocks ranged from 0 to 20 cm (Table 2).

Table 2. Dimensions of rocks sheltering lobsters and depth of standing water under the rocks at The Lobster Conservancy's intertidal study sites, Penobscot Bay Lobster Collaborative, 1998 and 1999 (n = 228).

Measurement	Mean (cm)	Std. Dev. (cm)	Minimum (cm)	Maximum (cm)
Rock length	40.2	17.85	7.6	121.9
Rock width	28.7	12.77	2.5	91.4
Rock height	15.8	8.06	2.5	50.8
Pool depth	5.8	3.82	0.0	20.0

Carapace length (CL) of lobsters ranged from 6 to 90 mm, with a mean of 38.5 ± 12.3 mm (n = 335; Figure 3). Two modal size class distributions were found (Figure 3). The smaller size class, measuring between 6 and 15 mm CL, represents young-of-the year (Cowan 1999a).

Sex ratio was skewed heavily toward males, with a sex ratio of nearly 2:1 male:female (chi-square test $p < 0.001$; Figure 4). The incidence of injury was measured as claw loss; one-quarter of lobsters were missing one or both claws (Figure 5).

Molting is a continual process, which consists of preparing for, undergoing and recovering from ecdysis (the shedding of the shell). Lobsters that are just about to shed have dark-red flesh and limb buds, and very dark shells. Lobsters that have recently gone through ecdysis have soft shells, which then become brittle before hardening completely. In this study, the majority of lobsters had hard shells, indicating that molting had not occurred recently. Recently molted lobsters, i.e., with soft or brittle shells, were first detected in June (Figure 6). The peak molting period occurred in August, then decreased gradually (Figure 6).

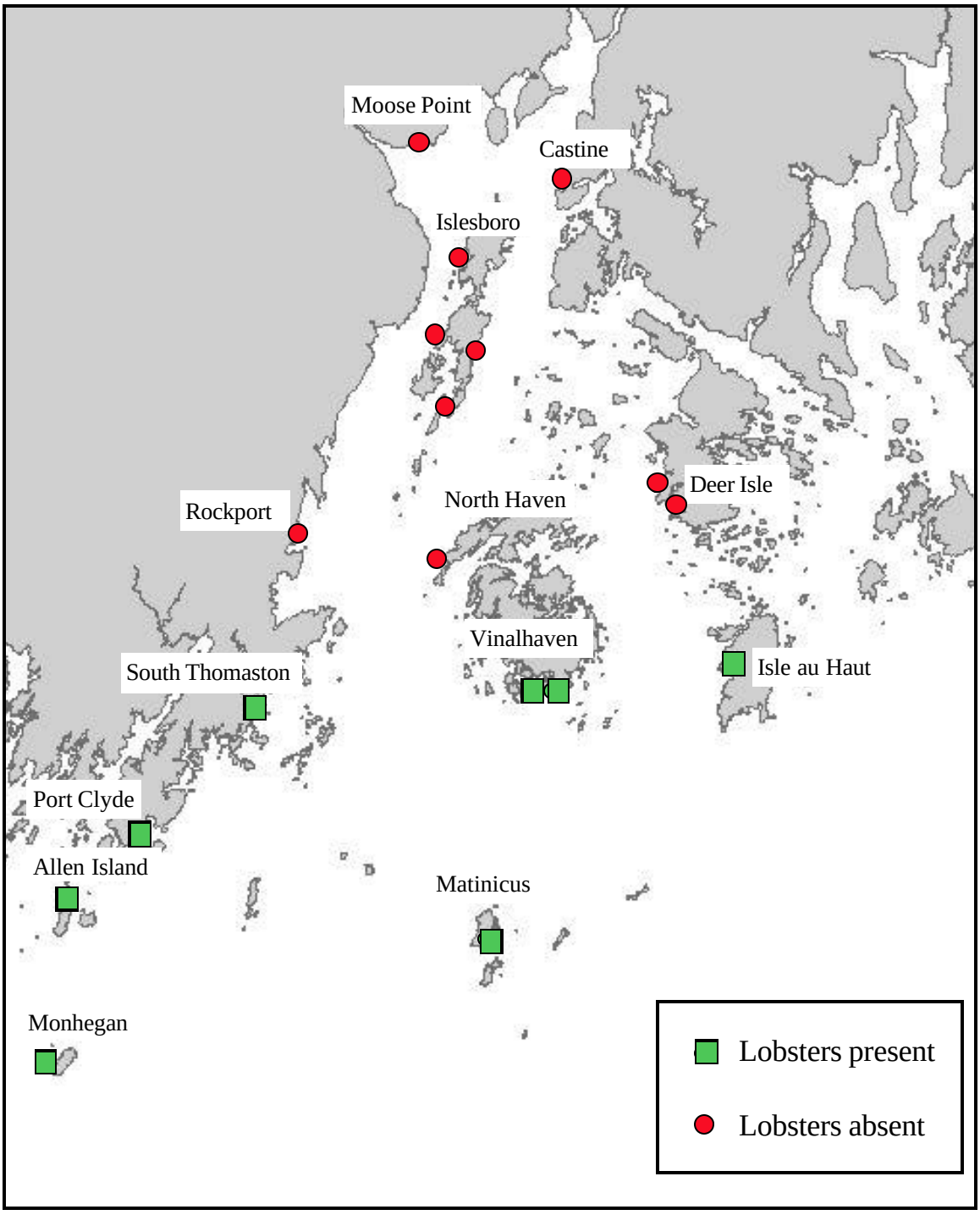


Figure 2. Presence or absence of juvenile lobsters at The Lobster Conservancy's intertidal study sites, Penobscot Bay Lobster Collaborative, 1998 and 1999. Lobsters were found in outer regions of the bay.

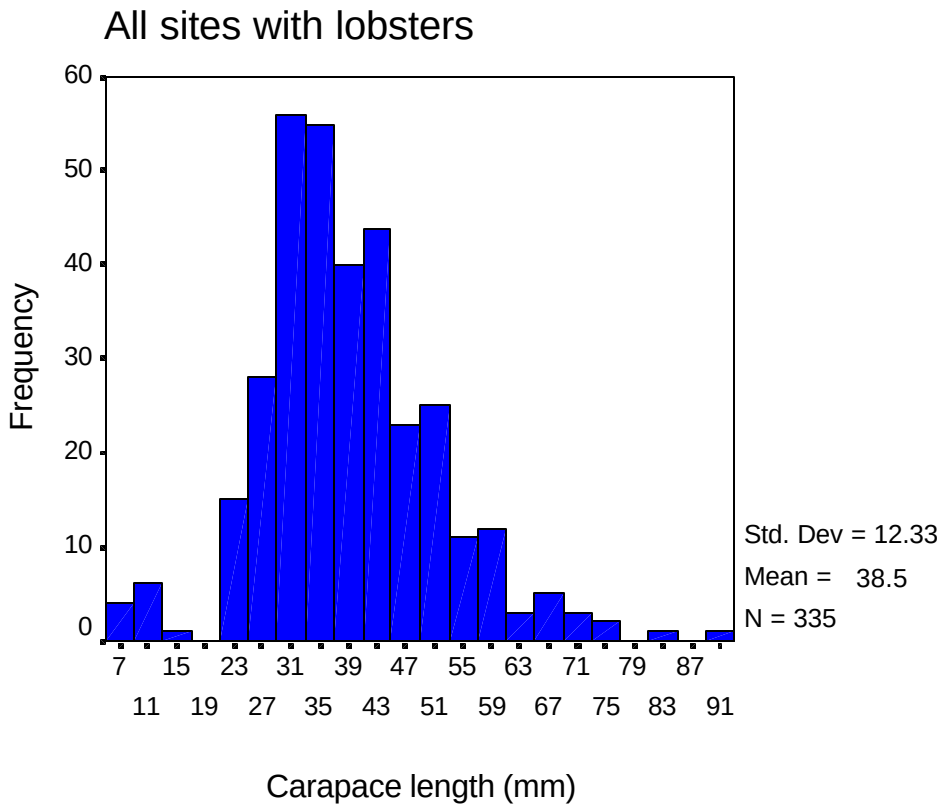


Figure 3. Size-frequency distribution of lobsters found at The Lobster Conservancy's 8 intertidal study sites, Penobscot Bay Lobster Collaborative, 1998 and 1999 (n = 335). A bimodal size distribution is apparent.

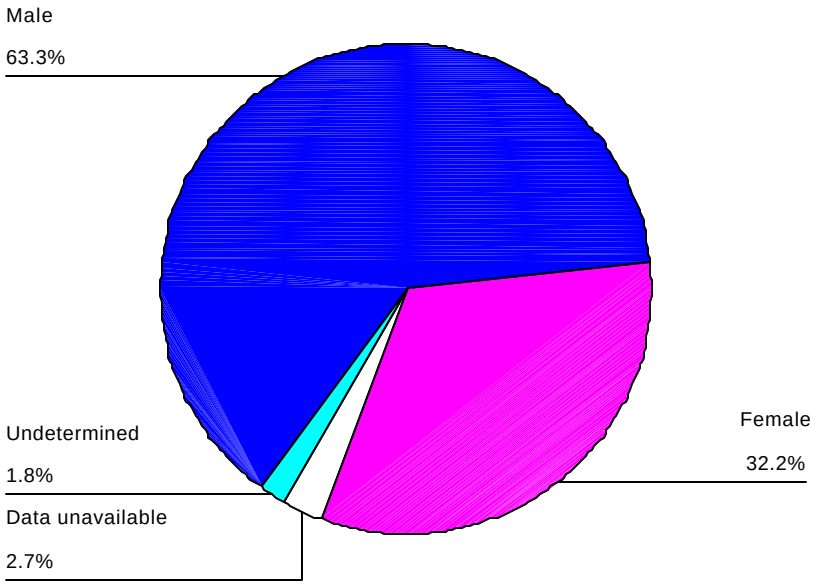


Figure 4. Sex composition of lobsters at The Lobster Conservancy's intertidal study sites, Penobscot Bay Lobster Collaborative, 1998 and 1999 (n = 335). (Sex is undetermined in lobsters < 10 mm CL). Males outnumbered females by 2:1.

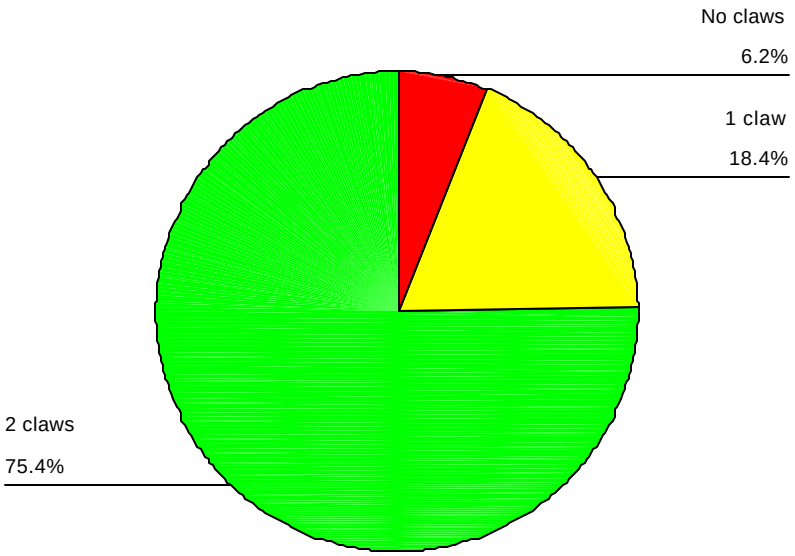
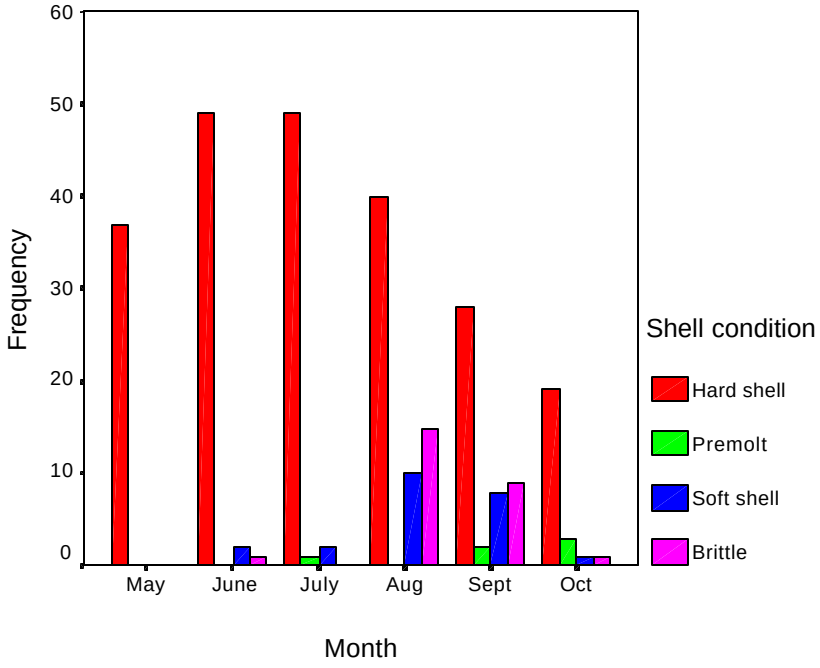


Figure 5. Incidence of injury of lobsters at The Lobster Conservancy's intertidal study sites, Penobscot Bay Lobster Collaborative, 1998 and 1999 (n = 335). Almost 25% of lobsters were missing at least one claw.

a)



b)

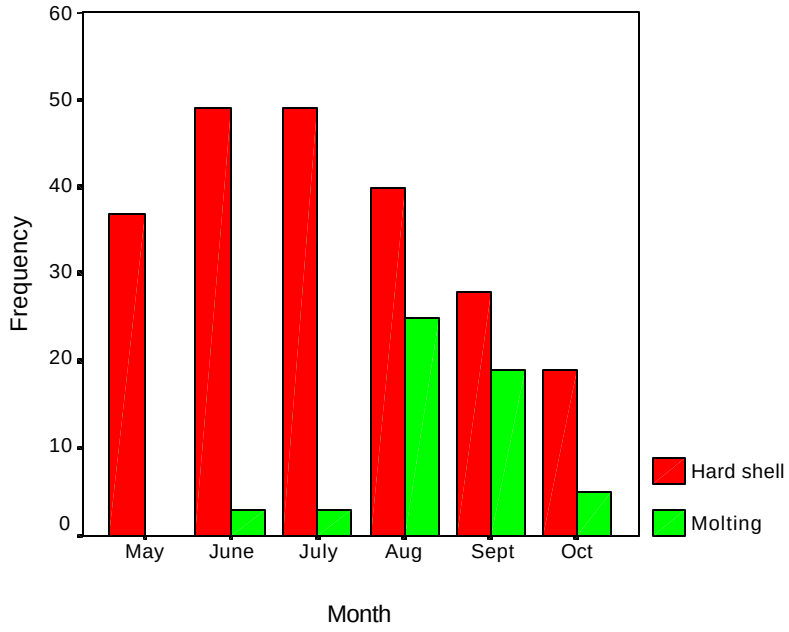


Figure 6. *a)* Shell condition of lobsters at The Lobster Conservancy's intertidal study sites, Penobscot Bay Lobster Collaborative, 1998 and 1999 (n = 277). A soft shell indicates a recent molt (within <1 day), while a brittle shell indicates a molt within the past week. *b*) Comparative frequency of non-molting (hard shell) versus molting lobsters (i.e., premolt, soft shell, and brittle-shelled lobsters combined; represented in green columns). The peak molting period occurred in August.

Inter-site comparisons

Over the study period and across all sites, density of lobsters ranged from 0 to 1.7 lobsters per m^2 (Table 3). Of the 8 sites where lobsters were found, the highest densities were observed at Allen Island, Port Clyde, and Vinalhaven-rocky, while the lowest densities were observed at Monhegan and Matinicus islands (Figure 7). Of the 5 sites that were studied in both years, the density was higher in outer regions of the bay than in inner regions (Figure 8)

The size-frequency distribution of lobsters varied between sites (Kruskal-Wallis test, $p < 0.001$). Mean lobster size at each site varied from 30.9 ± 12.3 mm CL at Isle au Haut to 56.5 ± 13.2 mm CL in eelgrass beds on Vinalhaven (Figure 9).

Young-of-the year lobsters (i.e., < 16 mm CL) were found at 5 sites (Allen Island, Port Clyde, South Thomaston, and Vinalhaven-rocky; Figure 10). The months in which these settlers were found were May, September, and October (Figure 11).

Table 3. Density of lobsters (number per m^2) at The Lobster Conservancy's intertidal study sites, Penobscot Bay Lobster Collaborative, 1998 and 1999. A dash indicates the site was not studied in a particular month.

Site	Sept 98	Oct 98	May 99	June 99	July 99	Aug 99	Sept 99
Allen Island	-	1.70	0.55	0.50	0.81	1.45	1.09
Port Clyde	0.80	0.40	0.30	0.45	0.85	1.20	0.60
South Thomaston	-	-	0.20	0.05	0.14	0.17	0.30
Isle au Haut	-	-	0.70	0.65	0.20	0.10	0.05
Vinalhaven: rocky	0.17	-	-	0	0.73	0.40	0.88
Vinalhaven: eel grass	-	-	-	0.07	0.38	0.40	0.03
Matinicus Island	-	-	-	0.04	0.05	0.10	-
Monhegan Island	-	-	-	0.11	0	0	-
Castine	-	-	0	0	0	-	-
Deer Isle	-	0	-	0	0	0	0
Islesboro: Grindle Pt.	-	-	0	0	0	0	0
Islesboro: Sprague Cove	-	-	0	0	0	0	0
Islesboro: Loranus Cove	-	-	0	0	0	-	-
Islesboro: Town Beach	-	-	0	-	0	-	-
Moose Point State Park	0	0	0	-	-	0	-
North Haven	-	-	0	0	0	0	0
Rockport	-	-	-	0	0	0	-
Stonington: Sand Beach	-	-	-	0	0	0	0

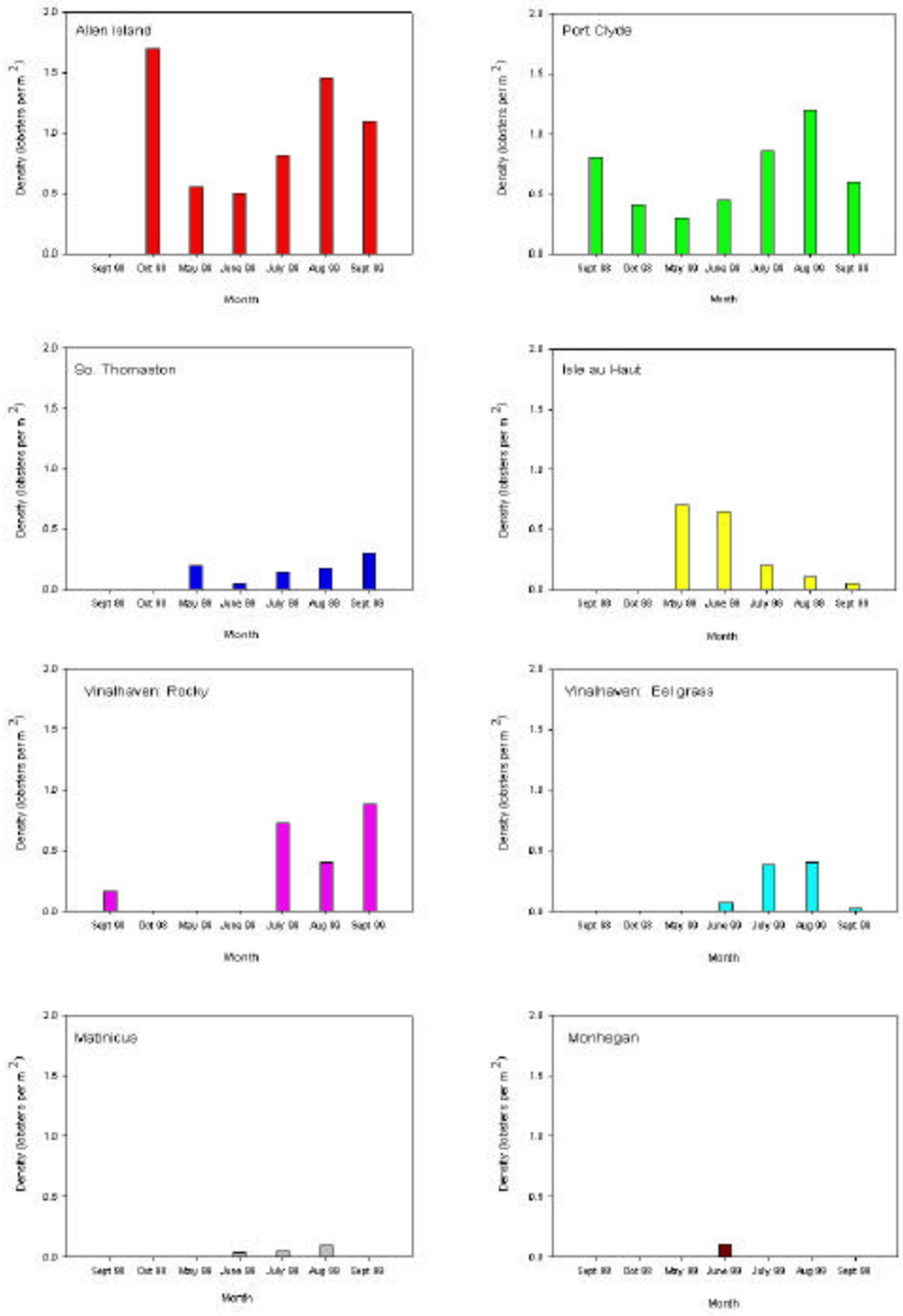


Figure 7. Monthly density of lobsters (number per m^2) found at The Lobster Conservancy's intertidal study sites, Penobscot Bay Lobster Collaborative, 1998 and 1999.

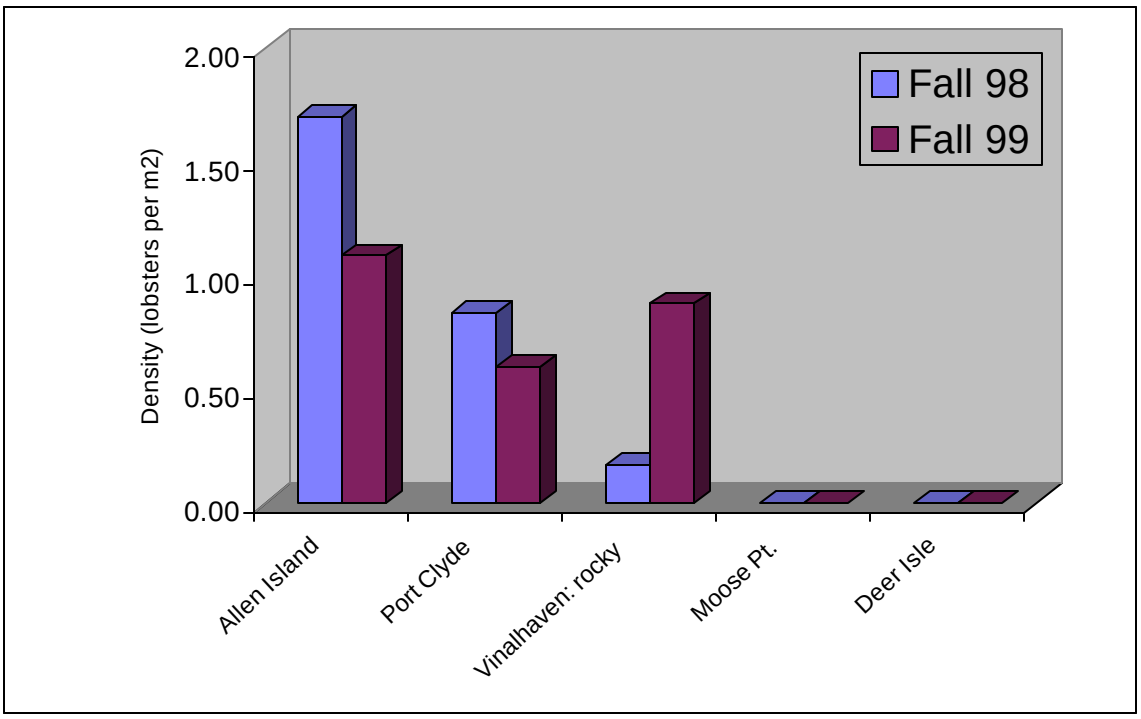


Figure 8. Density of juvenile lobsters in September or October at 5 sites studied in 1998 and 1999 as part of The Lobster Conservancy's intertidal research, Penobscot Bay Lobster Collaborative.

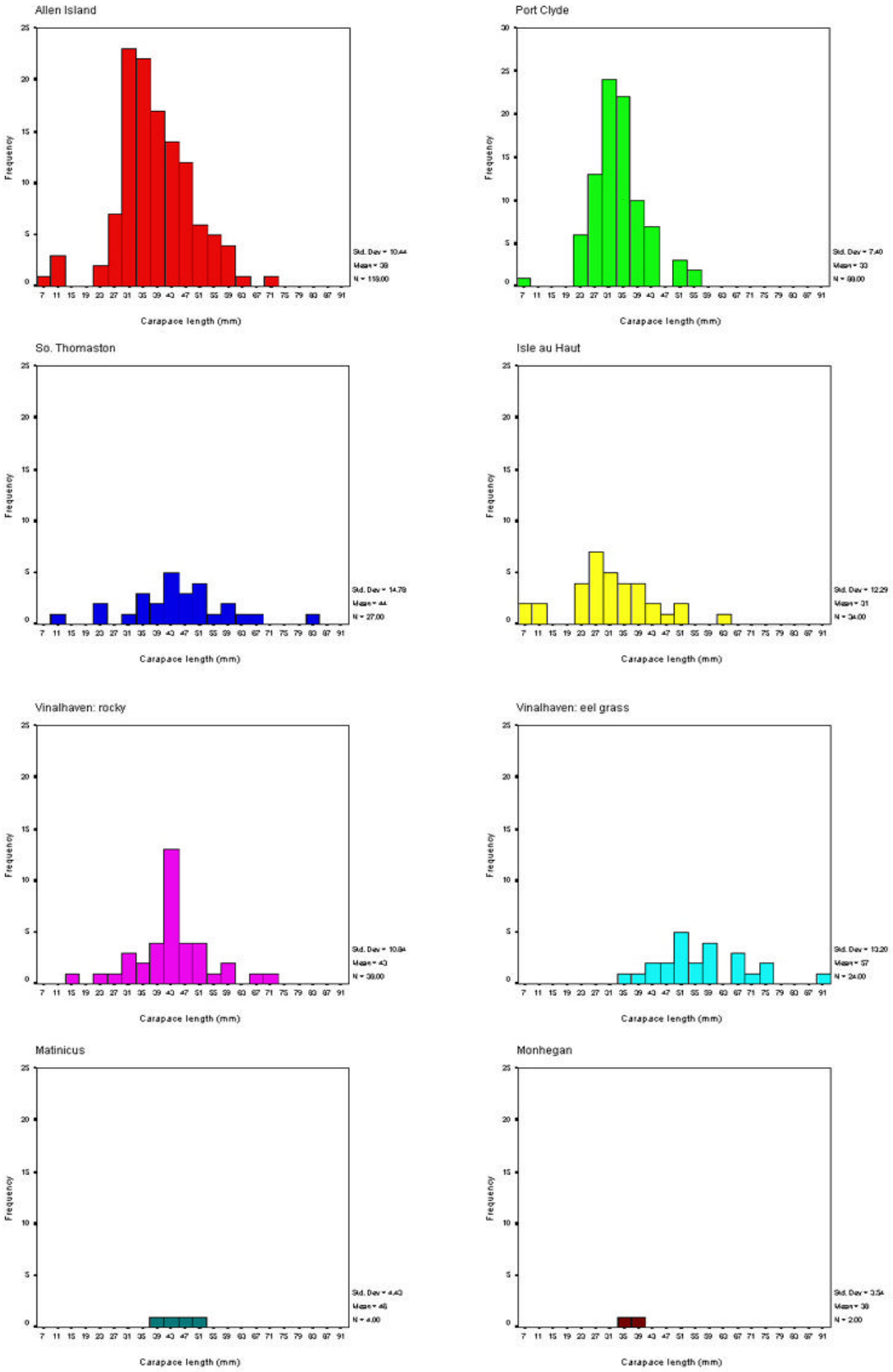


Figure 9. Size-frequency distribution of lobsters found at The Lobster Conservancy's intertidal study sites, Penobscot Bay Lobster Collaborative, 1998 and 1999.

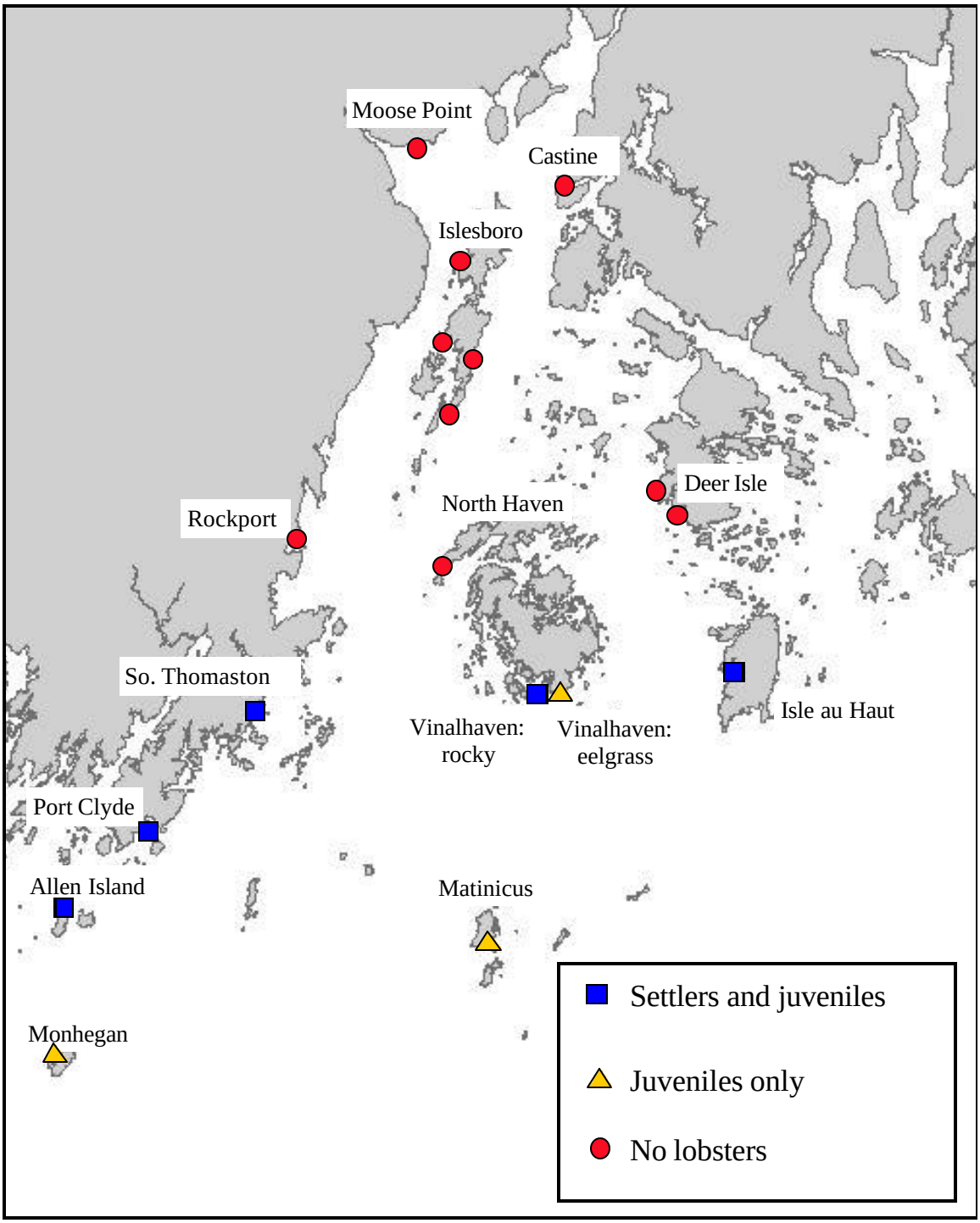


Figure 10. Size classes of lobsters found at The Lobster Conservancy's intertidal study sites, Penobscot Bay Lobster Collaborative, 1998 and 1999 (settlers < 16 mm CL; juveniles ≥ 16 mm CL.). Recently-settled lobsters were confined to a band across the mouth of the bay.

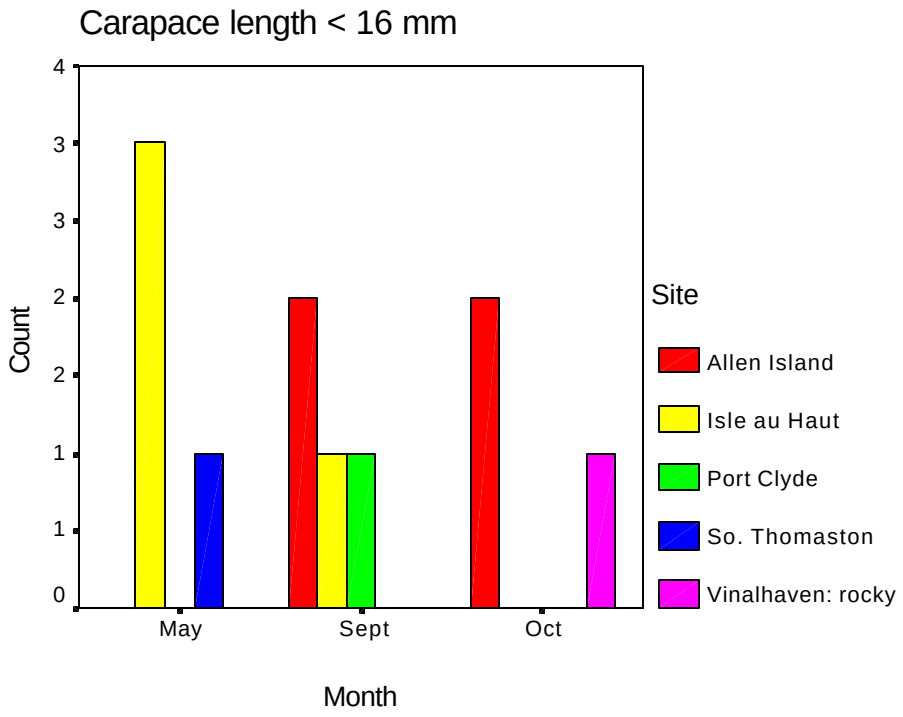


Figure 11. Recently-settled lobsters (< 16 mm CL) were found only in May, September and October at The Lobster Conservancy's intertidal study sites, Penobscot Bay Lobster Collaborative, 1998 and 1999 (n = 11). (Note that Isle au Haut and South Thomaston were not studied in October: Table 3)

Discussion

Community structure

The bimodal size-distribution of lobsters observed in Penobscot Bay is consistent with the pattern seen at Lowell's Cove, a long-term intertidal study site in Casco Bay, Maine (Cowan 1999a). The size class of young-of-the-year (4-15 mm CL) is clearly distinguishable from older year classes.

The male-biased sex ratio observed in Pen Bay has also been found consistently in the intertidal zone. Similar ratios have been observed at Lowell's Cove, 8 other sites in Harpswell, and 1 site in New Hampshire (Table 4). The reasons for this biased sex ratio are not known. In lobsters, sex is not determined until several months after settlement. It is possible that environmental factors such as temperature or salinity in the intertidal zone lead to the development of more males than females. Alternatively, the male-biased sex ratio may reflect differential rates of survival in, or tolerance to, this environment. It would be interesting to compare sex ratio between intertidal and subtidal nursery grounds as these data become available.

Table 4. Comparison of sex ratio of juvenile lobsters at The Lobster Conservancy's intertidal study sites around New England.

Area	M:F	Sample size
Penobscot Bay	2.0:1	335
Lowell's Cove[1]	1.9:1	9,677
Harpswell[2]	1.6:1	382
New Hampshire[3]	2.0:1	214

[1] Cowan 1999a; [2] Ellis and Cowan 1999a; [3]Ellis and Cowan 1999b

The incidence of injury was similar to patterns seen at other intertidal sites, in that the majority of lobsters had both claws. At 8 sites in Harpswell, 24% of lobsters had lost at least one claw (20% loss of one claw, 4% loss of both claws; n = 358) while in New Hampshire the percentage of claw loss was higher (25% loss of one claw, 10% loss of both claws; n = 214) (Ellis and Cowan 1999a, 1999b). Lobsters will drop a claw as a protective measure when attacked by a predator. It would be interesting to compare the incidence of injury in subtidal versus intertidal areas, to assess the relative protection from predators in each habitat, however, to the best of our knowledge, these data have not been collected in subtidal studies.

The peak molting period of juveniles in the intertidal zone occurred in August. This coincides with the peak molting season of adults in Maine, when landings are high and the greatest numbers of soft shell lobsters are caught. Growth rates of lobsters increase proportionally with increased temperature (Waddy et al. 1995). Thus it is not surprising that peak molting occurred in August, since temperatures generally increase as summer progresses.

The timing of settlement appears to extend beyond September and into the fall. Settlers were found at two intertidal sites in May, while others were found in September and October (Figure 11). Newly-settled lobsters (< 6 mm CL) have been observed in the intertidal zone of

Lowell's Cove in all months of the year except May and June (Cowan unpublished). Young-of-the year ≤ 10 mm CL have been observed at Lowell's Cove all 12 months of the year.

Habitat Use

Rocks that provided shelter to juvenile lobsters in Penobscot Bay (Table 2) had similar dimensions to those sampled at the long-term study site at Lowell's Cove, where average rock dimensions were approximately 30 x 30 x 10 cm (Cowan 1999a). In terms of horizontal dimensions, rocks in Pen Bay were rectangular (40 x 29 cm) rather than square as in Lowell's Cove. In both cases, however, rocks were generally flattened horizontally, i.e., height was less than ½ the length or width. Cobble, the preferred subtidal habitat of juvenile lobsters (Wahle and Steneck 1991) is more spherical or cube-shaped. In the intertidal zone somewhat flattened rocks would be less likely to be overturned by wave action than would cube-shaped or round rocks.

An alternative lobster habitat was documented on Vinalhaven, in which lobsters were found to burrow in eel grass. Lobsters have previously been observed in eel grass (e.g., Hudon 1987; Heck et al. 1989; Wahle and Steneck 1991). On Vinalhaven, no young-of-the-year were found in eel grass and the size distribution was biased toward larger animals than in the nearby rocky intertidal zone (Figure 9). This is consistent with subtidal studies in which eel grass beds sheltered lobsters of all sizes, but supported very low densities of lobsters <40 mm CL (Wahle and Steneck 1991).

Patterns of Distribution and Abundance

No juvenile lobsters were found at any of the study sites in inner regions of Penobscot Bay (Figure 2). This same pattern was observed in a 1995 survey of 15 intertidal sites in Casco Bay, Maine; juvenile lobsters were found at sites exposed to open waters, but not along the shoreline of inner bays and sounds (Cowan 1999a).

This distribution pattern suggests that biotic and abiotic factors may influence the suitability of locations as sites for benthic recruitment (Cowan 1999a). Potentially important physical factors include salinity, temperature, substrate type, wave action, ice scouring, and prevailing wind and water currents. Physical characteristics of settling sites exhibiting good intertidal habitat characteristics further upstream (i.e., inner bays) may be unsuitable as lobster nurseries due to extreme ice scouring, propensity of fresh-water runoff, and the amount of cover available in adjacent subtidal areas (mud bottom). Biological factors influencing suitability of settlement habitat may include proximity to postlarval supply, shelter availability as refuge from predators, and food availability.

If the contrast between inner and outer bays is influenced mainly by postlarval supply, it is possible that either currents carrying postlarvae do not reach inner regions of bays, or that postlarvae settle out of the water column in outer regions before currents reach the inner regions. Work being conducted by Dr. Lew Incze as part of the Penobscot Bay Lobster Collaborative may help to distinguish these competing hypotheses.

In our study, settlers were confined to a band across the mouth of Penobscot Bay (Figure 10). At extreme outer islands (Monhegan and Matinicus islands), no settlers were observed and juvenile densities were very low or zero. There are no reasons to doubt the accuracy of densities observed on Matinicus. In fact, subtidal studies in 1998 showed low settlement at Matinicus, and fairly low densities of early benthic phase lobsters (5-40 mm CL) (Steneck and Wilson in prep.). In the case of Monhegan Island, which showed high subtidal densities of settling and juvenile lobsters in 1998 (Steneck and Wilson in prep.), the lack of appropriate intertidal habitat may

have negatively biased our observed intertidal densities. The eastern side of the island is sheer cliffs, while the western, southern, and northern portions do not contain coves with rocks small enough for lobster monitors to overturn. The test monitoring site had some such rocks, but not for a full 20 meters, and thus was not truly appropriate for intertidal monitoring.

Because of this problem at Monhegan, we are limited to using Matinicus as example of an extreme outer island for comparison with sites at the mouth of the bay. The lack of settlers and the comparatively low densities of juveniles at Matinicus suggest a lower postlarval supply on Matinicus than across the mouth of the bay. This may be related to the inward turning of the EMCC in late summer and fall, which would turn it away from Matinicus. Alternatively, it may reflect a behavioral response of postlarvae which may preferentially settle in shallow, warm waters (Steneck and Wilson in prep.). Cues indicating shallow, warm water would be stronger and more abundant nearer the mainland than out to sea.

Along the mouth of the bay, intertidal densities of juvenile lobsters were higher in western regions than eastern regions. In western regions, densities decreased from south to north (i.e., Allen Island > Port Clyde > So. Thomaston). Similar patterns have been observed in the subtidal zone (Steneck and Wilson in prep.). These patterns of juvenile abundance support the hypothesis that regions with greater and earlier exposure to onshore currents will receive greater numbers of settling postlarvae.

Conclusions

The Lobster Conservancy's volunteers have proven to be reliable data collectors in Penobscot Bay. The data they gathered in 1998 and 1999 as part of the Penobscot Bay Lobster Collaborative have been used to determine community structure, habitat use, and timing of settlement and molting in the intertidal zone. Data from Pen Bay are remarkably consistent with data gathered by TLC's volunteers elsewhere in New England, and with long-term data collected by TLC's trained biologist.

The Pen Bay intertidal data have also been used to document patterns of abundance and distribution of juvenile lobsters, including young-of-the year. The observed patterns of settlement and juvenile abundance of lobsters in the intertidal zone support hypotheses that onshore currents, such as the Eastern Maine Coastal Current, deliver proportionally more postlarvae to western, outer regions of the bay. Extreme outer islands appear to receive fewer postlarvae.

In Penobscot Bay, the Intertidal Lobster Monitoring Program has proven to be not only an important form of educational outreach through its involvement of community volunteers, but also a useful scientific research program. The long-term goals of the Pen Bay Lobster Collaborative to use indices of settlement and juvenile abundance to make predictions about lobsters landings will be possible only with long-term monitoring. It is important that the Pen Bay Intertidal Lobster Monitoring Program be continued in upcoming years.

Acknowledgments

This project was supported by the Island Institute. Maine/New Hampshire Sea Grant provided funding to purchase monitoring equipment, and the Maine Community Foundation Community Fisheries Project supported production of a volunteer training handbook. We especially thank the many volunteers who dedicated their time and effort to collecting data.

References

Able, K.W., Heck, K.L. Jr., Fahay, M.P. Roman, C.T. 1988. Use of salt-marsh peat reefs by small juvenile lobsters on Cape Cod, Massachusetts. Estuaries 11(2): 83-86.

Cowan, D.F. 1999a. Method for assessing relative abundance, size-distribution, and growth of recently settled and early juvenile lobster (*Homarus americanus*) in the lower intertidal zone. Journal of Crustacean Biology, 19(4): in press.

Cowan, D.F. 1999b. Intertidal sampling for lobsters. In: Lobster Stock Assessment: Towards Greater Understanding, Collaboration and Improvement. Edited by P.M. Farrey, M.L. Mooney-Sues, and H.C. Tausig. Published by New England Aquarium, Boston. pp. 41-46

Cowan, D.F., J.K. Kanwit, and S.L. Ellis. 1999. Field Handbook: Intertidal Lobster Monitoring Program. Published by The Lobster Conservancy, Friendship, Maine. 48 pp.

Ellis, S.L., and D.F. Cowan 1999a. Preliminary Report on the Intertidal Lobster Monitoring Program, Harpswell, Maine 1998. Submitted to Maine Department of Marine Resources. 8 pp.

Ellis, S.L., and D.F. Cowan 1999b. Preliminary Report on the Intertidal Lobster Monitoring Program, Odiorne Point State Park, New Hampshire 1998. Submitted to New Hampshire Fish and Game Dept., 7 pp.

Heck, K.L., Jr., K.W. Able, M.P., Fahay, and C.T. Roman. 1989. Fishes and decapod crustaceans of Cape Cod eelgrass meadows: species composition, seasonal abundance patterns and comparison with unvegetated substrates. Estuaries 12(2): 59-65.

Hudon, C. 1987. Ecology and growth of postlarval and juvenile lobster, *Homarus americanus*, off Iles de la Madeleine (Quebec). Canadian Journal of Fisheries and Aquatic Sciences 44: 1855-1869

Incze, L.S. (ed.) 1998. Results of Penobscot Bay Marine Collaborative Workshop: Integration of Projects Related to Lobster Recruitment. 17-18 November 1998, River House, Camden, Maine.

Incze, L.S., R.A. Wahle, and J.S. Cobb. 1997. Qualitative relationships between postlarval productin and benthic recruitment in lobsters, *Homarus americanus*, Mar. Freshwater Res. 48: 729-743.

Steneck, R.S., and C. Wilson. in prep. The dynamics of lobster resources in Penobscot Bay: patterns and consequences of within bay settlement success.

Waddy, S. L., D. E. Aiken, and D. P. V. De Kleijn. 1995. Control of growth and reproduction. *In:* J. R. Factor, ed., Biology of the lobster, *Homarus americanus*. Pp. 217-266. Academic Press, New York, New York.

Wahle, R.A., and R.S. Steneck. 1991. Recruitment habitats and nursery grounds of the American lobster *Homarus americanus*: a demographic bottleneck? Marine Ecology Progress Series 69:231-243.

Appendix

Volunteer Training and Recruitment Presentations

Date	Speaker	Event	Location
8/10/98	Cowan	Volunteer Training	South Thomaston
9/3/98	Cowan	Information Session	Vinalhaven
9/10/98	Cowan	Volunteer Training	Vinalhaven
9/21/98	Cowan	Information Session	Deer Isle
10/4/98	Cowan	Volunteer Training	Deer Isle
10/8/98	Cowan	Information Session	Allen Island
10/9/98	Cowan	Volunteer Training	Vinalhaven
3/18/99	Ellis	Information Session	Vinalhaven
4/19/99	Ellis & Cowan	Volunteer Training	Isle au Haut
5/15/99	Ellis	Information Session	Islesboro
5/16/99	Ellis	Volunteer Training	Islesboro
5/17/99	Ellis	Round Table	Rockland
5/18/99	Ellis	Volunteer Training	South Thomaston
5/18/99	Ellis	Information Session	North Haven
5/19/99	Ellis	Volunteer Training	North Haven
6/14/99	Ellis	Volunteer Training	Rockport
6/14/99	Ellis	Volunteer Training	Deer Isle
6/16/99	Ellis	Volunteer Training	Monhegan
6/17/99	Ellis	Information Session	Matinicus
6/18/99	Ellis	Volunteer Training	Matinicus

Summary of The Lobsters Conservancy's number of study sites, trained volunteers, presentations and publications, Penobscot Bay Lobster Collaborative as of October 1999.

	1998	new in 1999	Total
Study Sites	5	13	18
Volunteers	23	28	45
Public Presentations	12	16	28
Related Publications	0	3	3

1998:
Volunteers in The Lobster Conservancy's Intertidal Lobster Monitoring Program, Penobscot Bay

Volunteer	Survey Site
Jane Roundy 207-594-5608 HC 32 Box 2 Holiday Beach Rd. Owl's Head, ME 04854 juround@midcoast.com	Drift Inn Beach Port Clyde
Julie Wortman jawortman@thewitness.org	Drift Inn Beach Port Clyde
Karol Kucinski 207-863-2053 RR1 Box 112 Vinalhaven High School Vinalhaven, ME SAD8-KK@VHAVEN.SAD8.K12.ME.US	Lanes Island Beach Vinalhaven
Bob Watts RR1 Box 112 Vinalhaven High School Vinalhaven, ME Bwatts@midcoast.com	Lanes Island Beach Vinalhaven
Stevie and Farley Mesko Vinalhaven, ME fm@foxislands.net	Vinalhaven
Sue Dempster P.O. Box 197 Vinalhaven, ME	Vinalhaven
John and Ginger Van Ness vanness@foxislands.net	Vinalhaven
Eric Davis P.O. Box 531 Vinalhaven, ME	Vinalhaven
Larry Hughes	Vinalhaven

1998 continued:
Volunteers in The Lobster Conservancy's Intertidal Lobster Monitoring Program, Penobscot Bay

Volunteer	**Survey Site**
Leroy and Donna Bridges 207-348-6992 Downeast Lobstermen's Association Box 521A Deer Isle, ME 04627	Sunset Deer Isle
Stephen Robbins III 207-367-5517 P.O. Box 649 Stonington, ME 04681	Deer Isle
Marnie Reed and Ken Crowell Sunset, ME 04683 mrcrowell@aol.com	Sunset Deer Isle
Charles Sullivan 1386 Airport Rd. Stonington, ME 04681	
Annie and Elaine Gardner 207-326-8829 3663 Shore Rd. Castine, ME 04421	Castine

1999:
Volunteers in The Lobster Conservancy's Intertidal Lobster Monitoring Program, Penobscot Bay

Jane Roundy and Julie Wortman HC 32 Box 2 Holiday Beach Rd. Owl's Head, Maine 04854	(207) 594-5608 juround@midcoast.com jawortman@thewitness.org	Port Clyde, Drift Inn Beach,
John and Ginger Van Ness P.O. Box 309 Vinalhaven, Maine 04863	vanness@foxislands.net 863-2558	Vinalhaven: Lanes Island Beach
Eric Davis and Tom Bridges		Lanes Island Beach, Vinalhaven
Kipp Quinby P.O. Box 19B Isle au Haut, Maine 04645	(207) 335-2600 mhart-quinby@revere.lib.me.us	Isle au Haut, Moore's Harbor,
Michael Wall moved to Cushing	(207) 446-3757 (wk)	Allen Island
Alfred Petterson 327 Waterman Beach Rd. So. Thomaston, ME 04858	(207) 594-7708	South Thomaston, Waterman Point
Leslie Fuller 88 Mason Cove Lane Cushing, ME 04563	(207) 354-0441 (h) (207) 594-9209 (wk) lfuller@islandinstitute.org	South Thomaston, Waterman Point
Annette Naegel 65 Mechanic St. Camden, ME 04843	(207) 236-9702	South Thomaston, Waterman Point
John Dietter and students North Haven Community School North Haven, ME	(207) 867-4707 jdietter@northhaven-cs.sad7.k12.me.us	North Haven
Steve and Jairus Miller P.O. Box 182 Islesboro, ME 04848	(207) 734-6907 iitsmill@midcoast.com	Islesboro: Loranus Cove, Town Beach
Bob Congdon 271 Pendelton Pt. Rd. Islesboro, ME 04848	(207) 734-8840 mcongdon@midcoast.com	Islesboro: Sprague Cove

1999 continued:
Volunteers in The Lobster Conservancy's Intertidal Lobster Monitoring Program, Penobscot Bay

Jim Mitchell P.O. Box 200 Islesboro, ME 04848	(207) 734-6724 (phone) (207) 734-9741	Islesboro, Sprague Cove
Ed and Alice Girvin P.O. Box 57 Islesboro, ME 04848	(207) 734-8130 eag@acadia.net	Islesboro, Grindle Point
Tyne Barber R.R. 1, Box 2590 Brooks, ME 04921	(207) 722-4196 Hadleigh1@aol.com	Islesboro, Grindle Point
Brian Dalton 89 Rockport Shores Rockport, Maine 04856	(207) 596-2959 bcdalton@mint.net	Rockport
Greg Kibitz 72 Thomaston St. Rockland, Maine 04841	(207) 596-0143 GREGDAVID@aol.com	Rockport
Annie & Elaine Gardner 3663 Shore Rd. Castine, Maine 04421	(207) 326-8829	Castine
Ken and Terry Bovee R.R. 1, Box 3355 Fifield Point Rd. Stonington, Maine 04681	bovee@downeast.net (207) 367-5934	Deer Isle and Stonington
Peter and Raquel Boehmer P.O. Box 365 Monhegan Island, ME 04852	peter@monhegan.com	Monhegan
Eva, Eric & Emily Murray P.O. Box 254 Matinicus Island, ME 04851	(207) 366-3695	Matinicus